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**Sound-symbol matching and blending ability among preschoolers
as a function of distinctive feature training and language ability**

Robinson, Susan Smith, Ph.D.

Iowa State University, 1987

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Sound-symbol matching and blending ability among
preschoolers as a function of distinctive
feature training and language ability

by

Susan Smith Robinson

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY

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INTRODUCTION

Learning to read requires the ability to correctly distinguish and recognize letter forms. However, research findings indicate that preschoolers have considerable difficulty in noting the differences between similar letters (Carnine, 1980; Copple, 1975; Nelson & Wein, 1976). In a study by Gibson, Gibson, Pick and Osser (1962), children ages four through eight were investigated to determine how well they could match letter-like symbols. The authors reported that errors decreased with age, with a large number at age four and only a few at age eight. In addition, the most frequent errors for preschoolers consisted of transformations in letter-like-symbols that might be considered analogous to alphabetic letter reversals (b/d), rotations (d/p), line to curve (v/u) and minor perceptual changes (h/n). Therefore, errors in matching letter forms appear to occur primarily before school starts and among visual symbols having high similarity.

These findings are in harmony with Mason's recent suggestion (1980) that for young children the initial stage in reading is "context dependent". The learner in

this stage does not focus on the individual letter units, but rather on the overall context in which the word is presented, such as recognizing the word "stop" only when it appears on a stop sign. As children move into the next stage of development called letter recognition, they begin to focus their attention on the letters that make up a word. Later, the child moves into an even more advanced stage requiring letter-sound analysis. Thus, it seems that preschoolers in the initial stage of reading development may be substantially different from readers in the cues they focus on in learning about reading.

Several reading experts have suggested that letter discrimination training might be an effective prereading activity for young children (Gibson & Levin, 1975; Guralnick, 1972; Paradis, 1974; Samuels, 1973; Williams, 1969). A number of researchers have reported that training children to note the distinctive features of highly similar letters (i.e., 'b' and 'd') enhances letter recognition (Carnine, 1980; Nelson & Wein, 1974; Pick, 1965; Samuels, 1973; Tawney, 1972; Williams, 1969). Guralnick (1972) concluded the following from a review of the literature on distinctive feature training:

The discrimination of graphic forms depends on

the individual becoming sensitive to the critical distinctive features or dimensions of difference which characterize these letter forms. A training program specifically designed to teach children to attend to these features should be valuable in increasing discrimination skills and eventually naming the letters in the alphabet." (p. 57).

Similarly, Williams (1969) suggested that children should receive more discrimination training that involves letter transformations at an early age.

A number of studies provide empirical support for recommending early visual discrimination training. Tawney (1972) reported that reinforcing four-year old children's responses for noting the critical features of letter-like symbols produced superior results on a matching to sample task than reinforcing children's responses on noncritical features. Nelson and Wein (1974) also reported that preschoolers taught to match a sample with high-confusion alternatives (e.g., 'b g d p') performed better on a posttest of letter discrimination than a group taught to match a sample with low-confusion alternatives (e.g., 'k o s r'). Similarly, Samuels (1973) found that children trained with high confusion letters learned to

discriminate and name letters in fewer trials than a group trained with low confusion letters. The improvement in learning letter names is particularly noteworthy because it suggests that discrimination training may facilitate the acquisition of skills beyond letter discrimination. Unfortunately, few studies have extended their investigations to examine whether or not perceptual training might aid other pertinent tasks required in learning to read, such as matching a letter to a sound or blending sounds together.

To date, many reading experts have proposed that perceptual difficulties found in school-aged children are secondary and a consequence of inadequacies in one or more of the language skills (e.g., Downing & Valtin, 1984; Liberman, 1971; Mattingly, 1972). In his extensive review of research on dyslexia (1979), Vellutino suggested that the differences found between dyslexic and normal readers on a variety of perceptual process measures are directly or indirectly attributable to poor performance in verbal processing ability. For example, children with a limited vocabulary or those who are unable to segment the sounds that form a word (c-a-t) may likely have difficulty in learning to read. Therefore, children's ability to visually distinguish the letters of the alphabet may be

confounded by basic inadequacies in one or more aspects of language ability.

Need for Study

In the past, studies that dealt with visual discrimination training appear to have been limited in terms of the extent to which they sampled reading-like tasks in their dependent measures. These studies selected dependent variables that tested only children's ability to recognize or match letters. It would appear that evaluations of discrimination training on highly similar letters should be expanded to include other tasks inherent in the reading process, such as matching sounds to visual symbols and blending sounds together. Several reading experts, such as Guralnick (1972), have suggested that pretraining children to notice the differences between highly similar letters would facilitate reading acquisition. Since preschool-aged children have been described as "context dependent" and empirical evidence has indicated that they have considerable difficulty in distinguishing among similar letters, it would seem that the preschool population is likely to benefit from such

training.

In addition, a plethora of empirical evidence supports the contention that language plays a primary role in learning to read (e.g., Mattingly, 1972). However, studies that have investigated the effects of visual discrimination training have failed to consider the variability in language knowledge found among children.

Purpose of Study

The purpose of the current study was to investigate how training preschoolers to notice the differences among letters affects their ability to match sounds and symbols and blend together sounds represented by letter-like symbols. In addition, this study also examined how preschoolers varying on a continuum of language knowledge performed on the two reading tasks and how language ability interacted with visual discrimination training.

Independent and Dependent Variables

There were two independent variables in this study. The first independent variable was training children to notice the structural differences among letters using two levels: one in which they received training on the distinctive features of highly similar letters and the other in which they received no training. The second independent variable was the measured language ability of the preschoolers. Two levels of language ability were designated using the median of 103 reported for subjects in this study. Scores that fell above the median were classified as high language ability and those below the median as low language ability. The two dependent variables were matching sounds to symbols and blending together sounds represented by artificial letters.

Research Hypotheses

The research hypotheses for this study were as follows:

1. First, it was hypothesized that there would be a difference between children who received visual discrimination training and those who did not receive the training on matching sounds to symbols. It was predicted that children who received the training would learn with a fewer number of trials to successfully match a sound to a letter-like symbol than children without the training. This hypothesis is based on Samuels' (1973) results which reported that a group receiving discrimination training learned letter names more quickly than a group without the training.

2. Second, it was hypothesized that children who demonstrated superior language ability would learn to match sounds to symbols in a fewer number of trials than those children who demonstrated low language ability. The language measure used in this study was Hresko, Reid and Hammill's (1981) Test of Early Language Development, a general assessment of preschool children's linguistic

ability. Research has reported a substantial relationship ($r=.65$) between preschoolers' language skills and reading knowledge (Huba & Robinson, 1986). Therefore, it was believed that preschoolers with high language ability would have an advantage over those with low language ability on the isolated reading task of matching sounds to symbols.

3. Third, it was hypothesized that there would be an interaction between children's language ability and the visual discrimination training on the dependent variable, matching sounds to symbols. It was predicted that this interaction would indicate that training is more effective for children demonstrating high language ability than for children demonstrating low language ability. Although empirical evidence is lacking, it was hypothesized that children who have advanced language ability would be more responsive to training about letter-like symbols because they may already be familiar with mapping abstract symbols to verbal utterances.

4. Fourth, it was hypothesized that there would be no difference between children who received visual discrimination training and those who did not on the dependent variable, blending sounds together. It was

predicted that the effects of the visual discrimination training would not be relevant for two reasons: 1) at the time at which blending ability is assessed all children would have already learned to match a sound with a symbol (and thus be able to discriminate among the symbols) as part of a earlier task taught to them in this study, and 2) the task of blending sounds together is heavily dependent upon children's linguistic skills.

5. Fifth, it was hypothesized that there would be a relationship between the children's language ability and the dependent variable, blending sounds together. It was predicted that children demonstrating high language ability would perform in a superior manner to those children with less language ability. Empirical evidence has suggested that preschoolers' language skills correlate quite well with reading knowledge (Huba & Robinson, 1986). The dependent variable, blending sounds together, is an important reading skill that draws primarily upon children's linguistic abilities.

6. Sixth, it was predicted that there would be no interaction between children's language ability and visual discrimination training on the dependent variable, blending sounds together. Due to the nature of sequencing

of the tasks, it was hypothesized that the visual discrimination training would no longer be relevant for two reasons: 1) at the time at which blending ability is assessed children would have already learned how to match a sound with a symbol (and thus be able to discriminate among the symbols) as part of earlier task taught to them in this study, and 2) the task is primarily dependent upon linguistic abilities.

Limitations of the Study

The major limitation of this study was that it was conducted with preschoolers from a middle to upper middle class socio-economic background who on the average tended to be well above average in IQ compared to the general population. Therefore, generalizing the findings to all preschoolers should be approached with caution. Secondly, because this study employed a brief, instructional treatment involving a one-to-one relationship between the examiner and the child, application to classroom settings should also be tempered. Finally, since children were classified into high and low language groups based on a median split, it may be that the groups were not sufficiently different in their language characteristics




to have addressed the hypotheses in this study. Each of these limitations should be considered when reviewing the results of the current study.

REVIEW OF LITERATURE

In recent years interest in preschoolers' concepts about reading have generated numerous studies about the young child's understanding of the visual characteristics of letters. This inquiry has suggested that young children begin to develop an understanding of printed letters long before they begin to read.

Perhaps one of the earliest studies to investigate the general development of printed symbols by children was conducted by Hildreth (1936). She described the developmental changes in preschooler's letter productions from ages three to six and noted that children's productions become more letter-like without instructional intervention. For example, when asked to write their name, children younger than three produced what could only be described as scribbles, but by age three and a half, children's writing samples were found to be distinctly different from drawings, with considerable tendency towards a horizontal and an up and down writing pattern. Around age four, the children seemed to discover separate letter units and were more interested in forming these.

Children's Visual Discrimination of Symbols

Although Hildreth looked at children's productions, other researchers have studied children's perceptions or interpretations of visual linguistic symbols (Copple, 1975; Ferreiro & Teberosky, 1979; Heydorn & Cheek, 1982; Lavine, 1977; Masonheimer, Drum, & Ehri, 1984; Nelson, Nilsson & Frascara, 1981; Nelson & Peoples, 1975, Popp, 1964). For example, in a study by Gibson, Gibson, Pick and Osser (1962), children from four through eight were examined to determine how well they could match single letter-like forms. The children were shown a standard and asked to match it with an identical form. The discrimination task required the children to search through thirteen alternatives which consisted of twelve transformations (i.e., reversals, rotations, etc.) and one form that was an exact copy of the standard. The authors reported that there was a decrease in errors on all the transformations as age increased, but that some transformations were more difficult to discriminate from the standard than others. For example, the errors for rotations () , reversals () , and changes of lines to curves () , were high for four-year-olds, but by eight years of age they had declined to almost zero. The authors explained this pattern by suggesting that these

structural features are not essential to the child's past experience in object identification. However, once the child is introduced to reading and becomes sensitized to such transformations, the errors drop markedly. In addition, the authors also reported that errors on minor perspective transformations (\pm) were high for four-year olds, but decreased only slightly, indicating that these changes are not critical to letter identification.

A study conducted a few years later (Popp, 1964) using lower case alphabetic letters seemed to substantiate the analysis by Gibson and her associates. Popp reported that letter confusions among five-year-olds arise primarily from reversals (b-d and p-q) and rotations (b-q, d-p, b-p, and n-u). Subsequent studies have provided further support for the contention that letter rotations and reversals are the major source of error on tasks of matching symbols (e.g., Williams, 1969).

Letter Discrimination Difficulty

The research to date suggests that errors in matching letter-like symbols appear to occur primarily before school starts and among visual symbols having high similarity (Gibson et al., 1962; Nelson & Peoples, 1975;

and Paradis, 1974). In harmony with these conclusions, Shankweiler and Liberman (1972) reported that after first grade, even children who have made little progress in learning to read have little difficulty in visually identifying single letters. In another study, Calfee, Chapman, and Venezky (1972) tested two groups of kindergarteners on how well they could discriminate single letters from each other. In this task the child was shown a letter such as "b", and asked to match it to one of several single letters presented, such as "d p b g". Kindergarteners performed quite well on these tasks (83% and 87% correct). The evidence suggests that most errors occur at the preschool level with the greatest difficulty in noting the differences between highly similar symbols consisting of reversals and rotations.

Visual Discrimination Training for Preschoolers

Reports of perceptual difficulties among preschoolers have caused some researchers to suggest that an effective prereading activity might be one that emphasized the contrastive features that distinguish confusable letters (Gibson, 1969; Gibson, Gibson, Pick & Osser, 1962; Gibson & Levin, 1975; Guralnick, 1972; Paradis, 1974). Samuels (1973) has suggested that children who are taught the

visually distinct characteristics of highly similar letters will be aided in letter recognition. This proposition is complemented by the work of Mason (1980). She conducted a longitudinal study that followed prereaders as they moved into reading. Her observations suggested that prereaders occupy an initial stage that is context dependent, where learners identify words as pictures. Prereaders reportedly could only identify words that were displayed in their appropriate context, such as "stop" on a stop sign. However, when preschoolers reach the second stage, called visual recognition, they could identify a few words out of context by the visual features of individual letters. Several researchers have indeed reported that prereaders differ substantially from beginning readers in the cues they attend to as they learn about reading (Ehri & Wilce, 1985; Gough, 1982; and Gough & Hillinger, 1980). Similarly, Masonheimer et al. (1984) examined the extent to which readers and prereaders utilized alphabetic letters to read words in environmental print samples. Prereaders, unlike readers, failed to notice alterations in common logos (e.g., XEPSI for PEPSI) and improved only slightly when the words were presented side by side. It appears that prereaders might be likely to benefit from training that would teach them to notice the differences between letters.

Methods of Visual Discrimination Training

A number of studies have compared alternative methods of instruction to determine the best way to teach children to notice the structural differences among letters (Bracey & Ward, 1980; Fernald, 1943; Pick, 1965; Polloway and Polloway, 1980; Nelsen, Nilsson, & Frascara, 1981; Samuels, 1973 and Williams, 1969). For example, Fernald (1943) proposed that a motor copying activity of repeatedly producing the letter shapes would contribute to the development of a schema that would form the basis of correct letter discrimination. However, her results indicated that the tracing or copying activities designed for children were not particularly effective for developing recognition of letters. Similarly, in a later study, Levin, Watson and Feldman (1963) compared the training effects of tracing the letters, copying them and just observing them. Again, the copying and motor activities were reported as totally ineffective. However, practice in noting the differences between letters without copying was reported as slightly effective. This finding provided the impetus for further investigations, as researchers sought more specific information about how noting the differences between letters might improve

letter recognition.

The distinctive features of symbols

In 1965, Pick studied first graders to determine what kind of learning would produce improvement in letter discrimination. She concluded that the most effective means was to teach children to detect the differences between similar letters. This conclusion provided support for the "distinctive feature" hypothesis that had been suggested by Gibson and her colleagues (Gibson & Gibson, 1955; Gibson, Gibson, Pick, & Osser, 1962). They have proposed that letter discrimination is facilitated by recognition of the critical or distinctive features of letters. According to these proponents, distinctive features are considered to be those differences which distinguish and provide contrasts among the symbols, such as the round curve that appears on the different sides of the stem in the letters b and d. Gibson and her associates have hypothesized that improvement in visual discrimination of letters rests on learning the contrastive features among symbols. Several subsequent studies have provided empirical support for the "distinctive feature" hypothesis.

In one study, Tawney (1972) examined four-year-old children's ability to discriminate letters. The children were divided into three groups. One group received tangible reinforcements (candy, toys, etc.) for noting the critical features among letters while the second group received the same tangible reinforcements for noting the noncritical features among letters. A third group received no discrimination training. Tawney's findings indicated that while all the groups made fewer errors on the posttest, the group taught to note the critical features among letters made significantly fewer errors than either of the other two groups.

The distinctive features of highly similar symbols

Studies by Williams (1969), Samuels (1973) and Nelson and Wein (1974) extended the investigations on "distinctive features" a step further. Williams (1969) reported that kindergarteners taught to note the differences between structurally similar letter-like symbols were superior, on a posttest of matching symbols, to kindergarteners who received the same training, but used easily distinguishable symbols. Similarly, Samuels (1973) trained two groups of kindergarteners to note the

critical differences between alphabetic letters. One group was trained to note the differences between letters that were highly similar (b d p q), while the other experimental group was trained to note the difference between letters that were easily distinguishable (c k t q). A third group functioned as a control group and received no visual discrimination training. Samuels reported that the group which had learned to note the distinctive features of the highly similar letters was superior to both the second experimental group and the control group on a posttest of letter discrimination and a transfer task of learning letter names. In addition, the group that had received the discrimination training using easily distinguishable letters was no more effective than the control group on these dependent measures. Therefore, visual discrimination training using stimuli of highly similar letters appears to play an important role in "distinctive feature" training. Similarly, Nelson and Wein (1974) reported that preschoolers who were taught to match letter alternatives of high confusion were superior to preschoolers who were taught to match letter alternatives of low confusion on a posttest of letter discrimination. Indeed, it seems that training that requires young children to note the differences between highly similar symbols yields the best results in learning

letter discrimination.

Gradual increase in stimulus similarity

Several of these earlier studies have also reported that although children improved significantly in letter discrimination when training involved high confusion letters, they also required significantly more training trials to meet criterion (Carnine, 1980; Nelson & Wein, 1974, 1976; Samuels, 1973). Concerned with this finding, Nelson and Wein (1976) and Carnine (1980) examined what would happen if training was gradually sequenced from matching low-confusion alternatives to matching high-confusion alternatives. In the Nelson and Wein study (1976) preschoolers were divided into three different training groups. One group received training that used only high-confusion alternatives, another group used only low-confusion alternatives and a third group used alternatives that gradually increased in structural similarity. The findings indicated that the sequenced group performed as well as the high-confusion group on discrimination of letters. However, the group presented with the gradual increase in stimulus similarity required even more training trials than the group presented with high-confusion letters. The increase in the number of

trials reported for the sequence group is in conflict with the findings reported by Carnine (1980). In this later study, the author found that gradually increasing the similarity among letters from easy to more difficult reduced the number of training trials required in distinctive-feature training.

Simultaneous versus successive presentation of stimulus

Finally, several researchers have provided additional information about the methods used to teach children to discriminate between highly similar letters. These studies examined whether there would be a difference in the way in which the stimuli are presented to subjects during the training. The studies investigated simultaneous presentations (a letter and response alternatives presented together) and successive presentations (a letter presented by itself, followed by response alternatives presented by themselves). Samuels (1969) reported that if stimulus similarity was low, the two procedures showed no difference on posttests of letter discrimination. However, if stimulus similarity was high, simultaneous presentation of alternatives was easier but less effective than a successive presentation in producing fewer errors. Lipsitt (1961) and Williams and Ackerman

(1971) have also reported that the delayed, matching-to-sample method using high confusion alternatives yields the fewest errors on measures of letter discrimination. Therefore, Samuels has suggested that simultaneous matching-to-sample should be followed by practice in successive matching-to-sample. According to Paradis (1974), this two stage presentation provides practice in determining the distinctive features of symbols and then assists in storing the features in long-term memory.

The Role of Visual Discrimination Training

It appears that even though these previous studies have contributed considerable information about visual discrimination training, they may be limited in their interpretations. The research to date has focused on determining the best method for teaching children to match symbols or identify letter names. It would appear that empirical evidence is still lacking in determining the role that this training might play in learning subsequent reading tasks, such as matching sounds to symbols or blending sounds together. Therefore, the question of whether or not training children to note the distinctive differences in letters will facilitate learning to read, remains unresolved as noted by Gibson, Gibson, Pick and

Osser (1962):

There is little or no evidence that these experiences transfer to reading. But if the typical matching tasks used variables which are significant for letter discrimination (instead of pictures of objects), there would certainly be greater potential transfer value. (pp. 905).

The Confounding Variable of Language Ability

In addition, these previous studies may not have considered an important confounding variable. In Vellutino's extensive review of research on dyslexia (1979) he suggested that the orientation and sequencing errors commonly attributed to poor readers (b/d, was/saw) may actually be linguistic rather than visual perceptual distortions. Vellutino claimed that the ability to decode visual symbols may be largely dependent upon the learner's success in various functions of language. He concluded that the differences found between dyslexic and normal readers on a variety of perceptual process measures are indicative of poor performance reported in verbal processing ability. For example, children who are unable to rhyme words or those who are unable to isolate the

sound in a given word ("c" in cat), may likely have difficulty in learning to read. Therefore, children's ability to visually discriminate among the letters of the alphabet may be confounded by basic inadequacies in one or more aspects of language ability.

In the past decade much research has been reported that supports this proposition (Downing & Valtin, 1984; Gleitman & Rozin 1977; Liberman, 1971; Mattingly, 1972; Rozin & Gleitman, 1977; Savin, 1972;). One aspect of language that was studied by Liberman and Shankweiler (1978) looked at children's ability to map alphabetic symbols to sounds. They reported that reading required explicit understanding that a word can be segmented into sounds. Another aspect of language was studied by Mattingly (1972), who coined the term "linguistic awareness". He stated that for a child to be able to decode words, the child must be made explicitly aware of the internal structure of language. He postulated that the basis of reading is the language process, initiated by the perception of the printed letters. Finally, Huba and Robinson (1986) used a test that measures the general language ability of four and five year olds, and reported a correlation of .65 with reading knowledge. These and other studies have provided support for the contention

held by many reading experts, that language plays a primary role in learning to read.

METHODOLOGY

This research investigated whether training preschoolers to note the contrastive features among highly similar artificial letters would facilitate learning subsequent reading tasks such as mapping a sound to a symbol or blending sounds together. In addition, this study also investigated whether children with high language ability would perform better on these tasks than children with low language ability.

Subjects

Forty-six four- and five- year old preschoolers were selected to participate in this study from a pool of 61 children whose parents had given permission to participate. The children attended three private preschools in middle- or upper-middle-class communities located in central Iowa. The 46 subjects were comprised of 21 males and 25 females who averaged 60 months in age ($SD=5.80$). The mean language standard score for the group was 103 ($SD=9.19$) measured on a scale with a mean of 100 and a standard deviation of 15. Table 1 presents the distribution of language scores for the entire sample. The average IQ for the group was 124 ($SD=13.95$).

TABLE 1. Frequency distribution of language scores for all subjects

Values	Frequency	Cumulative Percent
122 - 127	1	100.0
116 - 121	1	97.8
110 - 115	10	95.7
104 - 109	11	73.9
98 - 103	13	50.0
92 - 97	4	21.7
86 - 91	4	13.0
80 - 85	2	4.3

The mean language score for the experimental group was 102.91 (SD=9.40) and the mean score for the control group was 103.78 (SD=9.16). The average intelligence scores for the groups were 125.04 (SD=14.06) and 123.91 (SD=14.13), respectively. The lowest IQ in the experimental group was 99 and the lowest IQ in the control group was 93. In addition, the mean age in months for the experimental group was 59.69 (SD=5.91), and the mean age for the control group was 60.74 (SD= 5.76). No differences were found between the means of the two groups on language ability ($t(44) = .32$), intelligence ($t(44) = -.27$), and age ($t(44) = .61$).

For purposes of analysis, each subject was considered to be in either the top or the bottom half of the language score distribution (high and low language group, respectively). The average language score for the high language group was 110 (SD=4.90) and for the low language group was 96 (SD=6.21). The scores in the high language group ranged from 104 to 126 and the scores in the low language group ranged from 80 to 102.

The 46 subjects selected to participate in this study were those who met the following criteria. First, it was

necessary that each subject be matched within one standard deviation of another subject on IQ, as well as on language scores. Matching on these two variables simultaneously was believed to be pertinent for this particular study because of the use of a small sample size and because of the relevant role that these variables are reported to play in reading tasks.

A second criterion for participants of this study was that they could not be knowledgeable about decoding words. Therefore, a test measuring children's ability to decode three-letter words was used. This screening process was necessary because the focus of the study was to evaluate the effectiveness of the visual discrimination training as a prereading activity. That is, to investigate whether the training (or the language ability of children) facilitated learning to map sounds to symbols or blend sounds together. Therefore, preschoolers who exhibited little knowledge of word decoding were sought as participants for this study.

The third criterion required that the subjects speak English as their primary language. The nature of the dependent variables used in this study appeared to be heavily dependent upon language ability. It was therefore

believed that children not fluent in English would be at a considerable disadvantage.

The final criterion required that a subject be cooperative and willing to participate in the tasks. Therefore, only preschoolers who wanted to participate in the activities were selected.

Materials

Introduction

Three existing standardized tests were used in this study: The Slosson Intelligence Test (Slosson, 1963), the Test of Early Language Development (Hresko, Reid, & Hammill, 1981), and the Diagnostic Test of Phonic Skills (Bryant, 1963). In addition, materials were developed for the following five different phases of the study: 1) warm-up activity, 2) visual discrimination training, 3) matching sounds to symbols, 4) blending sounds together, and 5) identifying letter names and sounds. They are described as follows:

Assessment of intelligence

The Slosson Intelligence Test (Slosson, 1981) was used to assess each subject's IQ, using the 1981 norms. This standardized test has been normed on 1109 individuals ranging in chronological age from 27 to 216 months and the manual reports an overall reliability of not less than .95. However, reliability estimates obtained for restricted range subgroups were lower than that for the entire sample, with a reported correlation of .93 for the age group 6.6 years and younger.

Assessment of language ability

Scores from the Test of Early Language Development (Hresko, Reid, & Hammill, 1981) were used for a general assessment of language ability. This instrument measures various aspects of receptive and expressive language. It also measures two dimensions of language referred to as form and content. The form of language deals with the ability to detect grammatically and phonetically correct phrases and sentences. The content of language refers to the ability to express and retrieve meaning from speech.

This instrument was developed and normed for use with

preschoolers. That is, the Test of Early Language Development (Hresko, Reid, & Hammill, 1981) was standardized on the test performance of 1184 children who ranged in age from 3 to 7 years old. The internal consistency reliability which reflects the degree of homogeneity among the items was .90. A coefficient of .90 was also reported for stability reliability, a measure of the extent to which a subject's performance is constant over time.

Evidence was also provided by the authors of the measure to indicate that the test has content validity, criterion-related validity, and construct validity. Specifically, a correlation coefficient of .67 was reported between the Test of Early Language Development (Hresko, Reid, & Hammill, 1981) and the Listening subtest of the Metropolitan Achievement Tests (Durost, Bixler, Wrightstone, Prescott, & Barlow, 1970). In addition, the correlation between the Test of Early Language Development and the subtest Word Meaning and Listening from the Metropolitan Readiness Tests (Hildreth, Griffiths, & McGauvran, 1969) was .75. In sum, the Test of early language development appears to be a valid and reliable measure for a general assessment of preschoolers' language ability.

Assessment of Decoding Skills

The Diagnostic Test of Phonic Skills (Bryant, 1963) was used to assess the decoding capabilities of the subjects. This is a standardized test consisting of three- and four-letter nonsense words presented to children on 3 x 5 cards. The test measures knowledge of initial and final consonants, short and long vowels, consonant blends, 'r' blends, combination vowels (e.g., 'oi', 'au'), and combined syllables with affixes. In the current study, only the first section of the test was used. This section is composed of 24 nonsense words that assess only the initial and final consonants, combination vowels, 'r' blends, and the five short vowels.

Distinctive feature training warm-up activity

Three cards displaying lower-case alphabetic letters were used in the warm-up activity. The three cards displayed a single letter at the top of the card with three more letters printed below and horizontally across each card (Figure 1). Research has reported (Allioti, 1980; Gibson et al., 1962; Popp, 1964; Williams, 1969) that reversals and rotations of symbols produce the most

b
x k b

p
s p b

d
p b d

Figure 1. Stimuli utilized in warm-up activity

confusion for children on tasks requiring letter discrimination. Therefore, the three single letters used in this activity were 'b', 'p', and 'd'. The alternatives increased in structural similarity, with the simplest combination showing 'x b k', the second combination showing 's p b' and the most difficult combination showing 'b d p' (Popp, 1964). These letter combinations were taken from Popp's (1964) study on matching to sample tasks involving lower-case alphabetic letters. The letters were printed in black on 5 x 8 cards and presented in the following combinations: 'b' with 'x, k, b'; 'p' with 's, p, b'; and 'd' with 'p, b, and d'.

Distinctive feature training

Three letter-like symbols and their structurally similar transformations were used in this study. These symbols were easily distinguishable from the letters of the alphabet. Calfee (1977) has suggested that some children may already know their letter names, putting them at a distinct advantage in performance on matching tasks. Thus, artificial letters were selected from an earlier study by Gibson et al. (1962). The symbols were reported to have been the result of an analysis of the English letters and conform to the same rules as the letters in

the alphabet (e.g. number of strokes, angles, etc.).

Twenty-seven 5 x 8 cards were used in the visual discrimination training. For the three standard symbols there were two sets of cards showing alternative choices, 9 in a simultaneous presentation and 18 in a successive presentation. Using a simultaneous presentation, the first set showed the standard symbol and the letter-like alternatives printed on the same card. Therefore, nine cards displayed a standard and three letter-like alternatives (Figure 2). The second set of cards was presented using a successive presentation (Figure 3). That is, nine of the cards had a single, letter-like symbol printed at the top. Another nine cards showed three alternative, letter-like symbols printed horizontally across each card. Only one of the alternatives was an exact copy of the standard. The other alternatives were highly similar to the standard, with transformations consisting of a 180 degree rotation or a right-to-left reversal. These transformations were reported by researchers (Gibson et al., 1962; Popp, 1964; Williams, 1969) to be the major sources of error for children in matching letters and letter-like symbols.

All graphic symbols were approximately 1 x 1 inch in

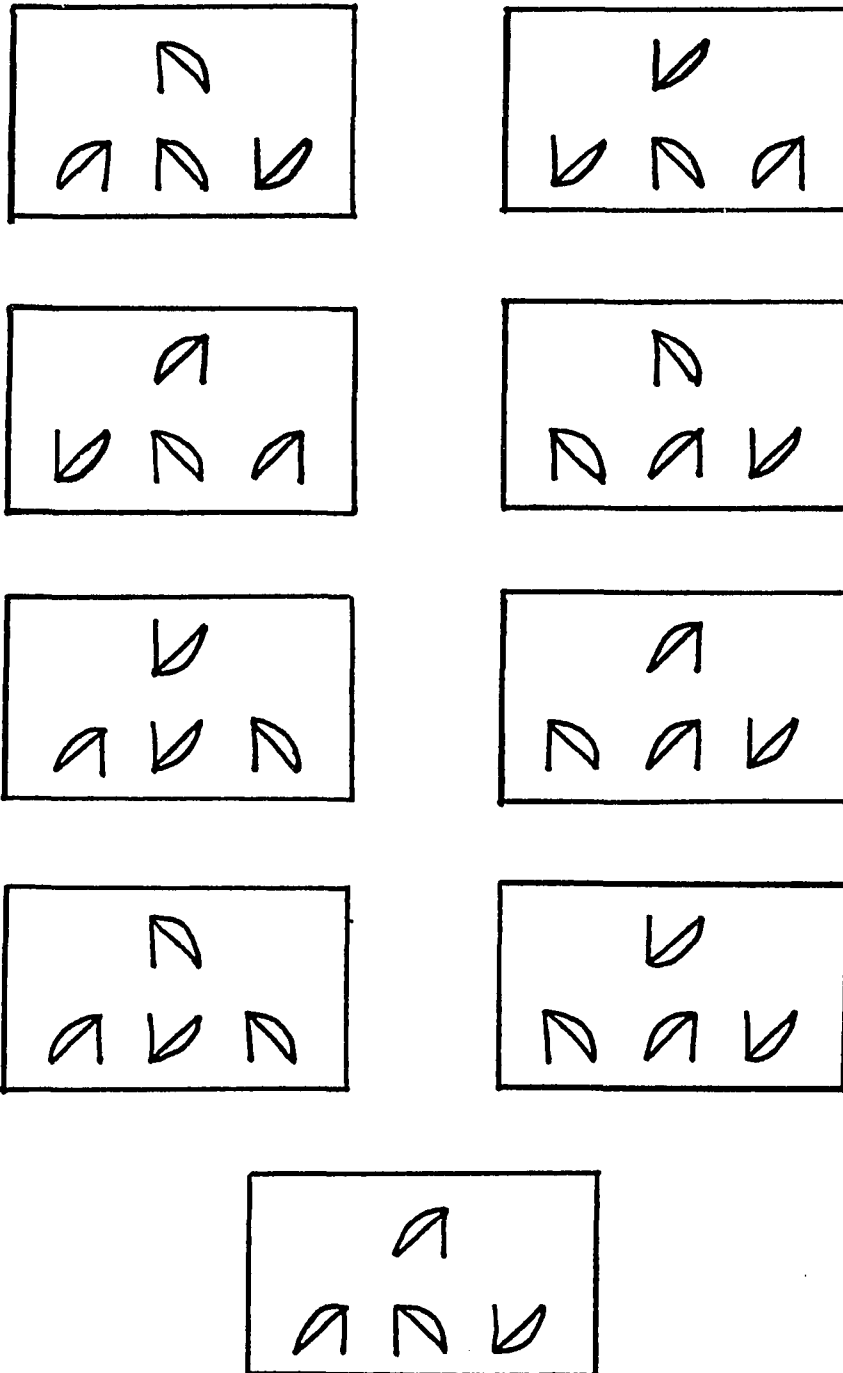


Figure 2. Stimuli utilized in simultaneous presentation of letter-like symbols for distinctive feature training

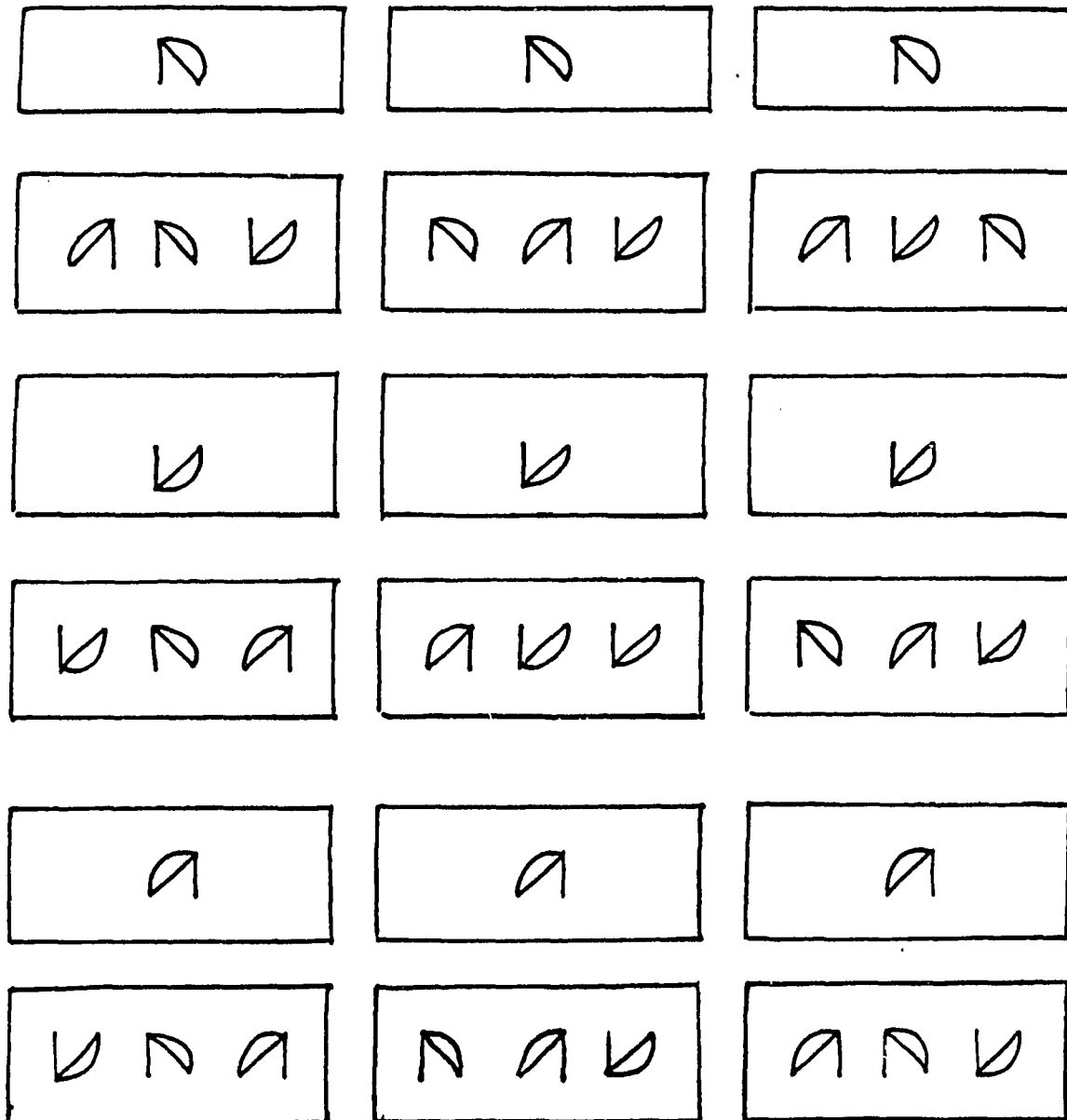


Figure 3. Stimuli utilized in successive presentation of letter-like symbols for distinctive feature training

diameter and printed in black in a fixed random order (i.e., all subjects were presented with the same sequence).

Matching sounds to symbols

The three letter-like symbols presented in the visual discrimination training were used in the matching sounds to symbols task. Each symbol represented a designated sound and was displayed in black on an individual 5 x 8 card (Figure 4).

Blending sounds together

Before administering the tasks for blending sounds together, a demonstration involving three pairs of letter-like symbols was presented (Figure 5). The symbols were taken from the study conducted by Gibson and her associates (1962). The artificial symbols represented the sounds that make up the words 'me', 'so', and 'mow'. They were printed in black on 5 x 8 cards.

For the task following the demonstration, four pairs of letter-like symbols were individually presented to the children representing the sounds that form the words:

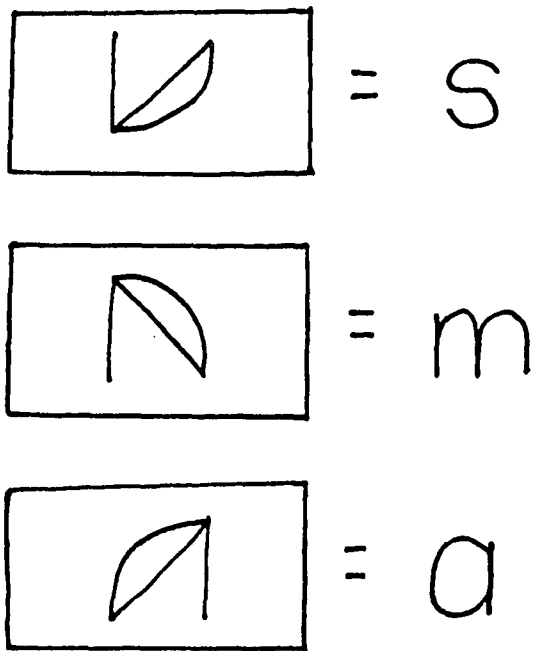


Figure 4. Stimuli and corresponding name utilized in matching-sounds-to-symbols task

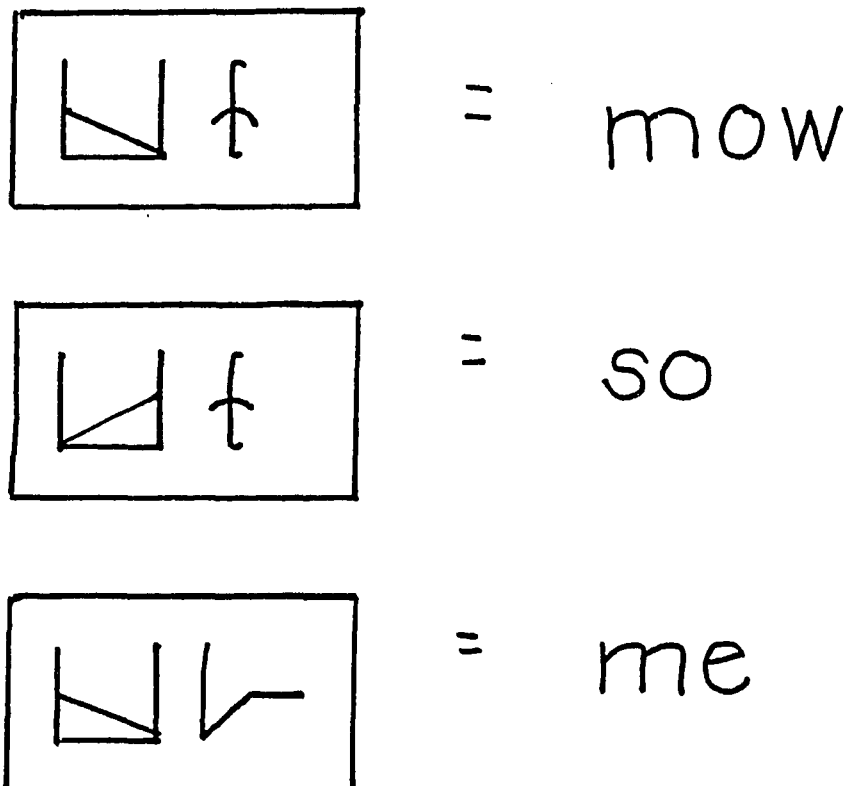


Figure 5. Stimuli utilized in demonstration preceding blending-sounds-together tasks

'say', 'may', 'aim', and 'ace'. All pairs of letter-like symbols were printed in black on 5 x 8 cards (Figure 6).

Identifying three alphabetic letter names and sounds

Immediately following the tasks on blending the sounds together, all subjects were shown three 5 x 8 cards that displayed the upper and lower case letters of 'm', 's' and 'a' (Figure 7).

Procedure

Subject selection

Scores from individually administered tests measuring intelligence and language ability were acquired for each subject from another research project (Huba, 1987).

In addition, children's ability to decode three- and four-letter words was also assessed. A child who could correctly identify more than one of the twenty-four words was dropped from the study. However, if the subject was unable to identify any of the first five words, the testing was stopped. As a result of this criterion level, seven subjects were eliminated from the original pool of

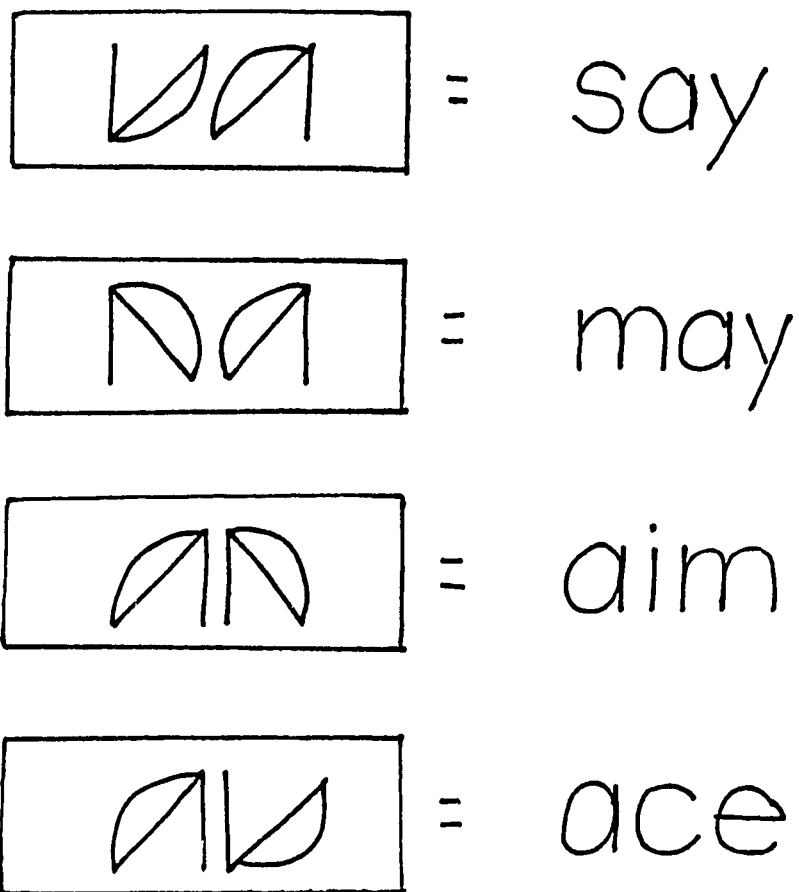


Figure 6. Stimuli utilized in blending-sounds-together tasks .

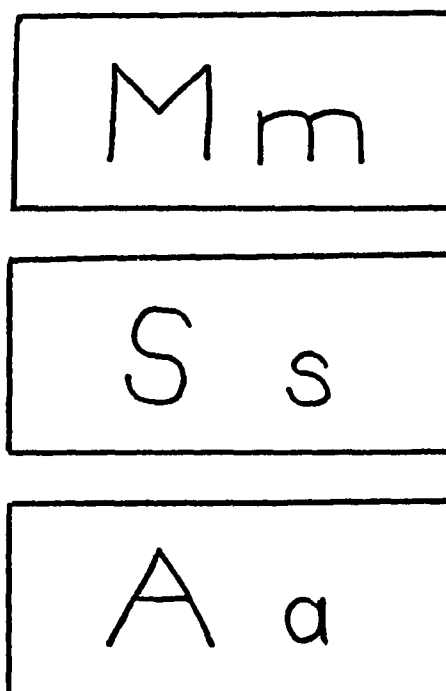


Figure 7. Stimuli utilized in identifying letter names and sounds

61. In addition, eight other subjects were unable to meet the other criteria for selection outlined above in the subject's section.

Using the scores acquired from the preexisting measures the subjects were matched on I.Q. and language ability within one standard deviation of each other and members of each pair were randomly assigned to either the experimental or control group.

It is of interest that one subject was unable to successfully match the symbols in the distinctive feature training. Indeed, in the simultaneous presentation of symbols where most subjects scored well (61% matched correctly on the first trial), she matched only half of the letter-like symbols correctly by the third trial. This performance caused her considerable frustration and she requested the activity to be stopped. She was dropped from the study and replaced by a subject from the pool who could be successfully matched with the other member of her pair.

Overall schedule of activities

The experimenter worked individually with each subject in the two groups. Subjects in the experimental group met twice with the experimenter, while subjects in the control group met only once. Results of a pilot study indicated that two sessions were needed for the experimental group to eliminate the potential of bias caused by fatigue.

Figure 8 outlines the schedule of activities received by the experimental and control groups. These activities are described in detail in the following sections.

Distinctive feature training warm-up activity

In the first session the experimental group received a warm-up activity followed by the visual discrimination training and testing to criterion. The warm-up activity was designed to clarify the subjects' understanding of "matching shapes that were exactly the same". Popp (1964) suggested that children should be checked on their understanding of the meaning of "exactly the same" before they are asked to match symbols. Therefore, the following instructions were included in this study to assure an

	Experimental	Control
<hr/>		
<u>Day 1</u>		
Distinctive feature training		
- warm-up activity	X	
- (session 1)	X	
 <u>Day 2</u>		
Distinctive feature training		
- (session 2)	X	
Irrelevant warm-up activity		X
Matching sounds to symbols		
- demonstration	X	X
- training to criterion	X	X
Blending sounds together		
- demonstration	X	X
- task without assistance	X	X
- task with assistance	X	X
Identifying letter names	X	X
Identifying letter sounds	X	X

Figure 8. Schedule of activities for experimental and control groups

understanding of the matching task:

Point to the shape at the top of the card. Good.

Now, find a shape that looks exactly like the one at the top. Point to it. Good.

Each card was presented to the child for about 5 seconds. If the child responded correctly, she/he was praised. However, if the child was incorrect, the experimenter said, "No, that is not exactly the same as the shape above. Point to the one that is exactly the same. Good. Why is this one exactly the same and the not the other one?"

Distinctive feature training (session 1)

Following the warm-up activity, the distinctive feature training task was administered to the experimental group. To teach the subjects to distinguish between highly similar letters, a simultaneous matching to sample presentation was used, followed by a successive matching to sample presentation (Samuels, 1969). In the simultaneous mode, all the stimuli were presented together, permitting the subject to look back and forth from the standard symbol at the top to the alternatives

below. Instructions for the simultaneous mode were as follows:

Point to the shape at the top of this card. Good.
Now, find the shape that looks exactly like the one
at the top. Point to it. Good.

The cards were exposed for about 5 seconds during which time the subjects could respond. If correct, the subject was praised; if wrong, the experimenter said, "No" and asked the child to point to the correct response. The subject was given discrimination training in the simultaneous mode until she/he got one complete trial correct. A complete trial was defined as correct responses on all nine consecutive cards.

In the successive mode, the standard symbol was first exposed by itself for about 5 seconds. Then the card showing the response alternatives was shown for about 5 seconds. The instructions given to the subjects were as follows:

Now let's change the game a little. This time I'm going to show you one of the shapes all by itself. I want you to try and remember exactly what it looks

like. Then I'm going to cover the card and show you a new card with three of the shapes. I'll ask you to point to the one that was exactly the same as the one I covered-up. Okay, let's try it. Look at this shape. (After 5 seconds the examiner covers the card with a second card which shows the three alternatives.) Now point to the shape on this card which looks exactly like the shape you looked at on the other card.

Each subject was given nine presentations that required successive matching of each of the three, standard, letter-like symbols with the exact copy that appeared among the alternatives. Feedback was given to all responses. If correct, the subject was praised; if wrong, the experimenter said, "No" and asked the child to point to the one that was exactly the same. Criterion was met when the subject gave an error-free response for one complete trial. One successful trial was defined as correctly matching the three standards with the appropriate alternative in nine consecutive presentations. Once this criterion level was met, session 1 was terminated.

Distinctive feature training (session 2)

On a separate day, the examiner met individually again with the subjects in the experimental group (session 2). The mean number of days that transpired between session 1 and session 2 for the subjects in the experimental group was 3.4 days, with a range from 1 to 14 days. Session 2 began by readministering to the subjects only the successive mode of the visual discrimination task. Once a subject reached criterion, the first measure for the matching sounds to symbols task was administered.

Matching sounds to symbols

All subjects in the study participated in the matching sounds to symbols task, which began with a brief demonstration. The demonstration involved presenting each letter-like symbol to the subject for approximately 5 seconds, while the sound of a letter was pronounced ('m', 's', or 'a'). The child was then asked to look at the artificial letter and repeat the sound the symbol represented. The instructions for this demonstration were as follows:

Let's play a game. Look at these shapes. Let's pretend they are letters. There are three different letters. One looks like this, the other looks like this and the third one looks like this (the experimenter points to the different letters). Each of these letters has a different sound. I want you to try and remember the sound that goes with each letter. Okay? Let's try one. Look at this letter. It says _____. Your turn. What does this letter say? Good. So, if I show you this letter and ask you what it says, what will you tell me? Good.

After the children were presented with each of the standard letter-like symbols and asked to repeat the sound twice, the symbols were then presented in a fixed random order for the children to match with a correct sound. The subjects were told to try to say the appropriate sound when the letter was presented before the examiner said the sound. The correct sound was given by the experimenter after an approximate five second interval. Feedback was given to all responses and scores tabulated for each response. If correct, the subject was praised; if wrong, the experimenter said, "No" and identified the correct sound. Criterion was reached when a subject gave a correct response for each letter-like symbol on one

complete trial. A successful trial was defined as correctly matching the three consecutive symbols and their designated sounds. The following two measures were used to determine the success of the subjects on matching sounds to symbols: 1) the number of correct matches on the first trial, and 2) the total number of presentations needed to learn to match sounds with symbols to the criterion level.

Blending sounds together

Once all the subjects completed the matching sounds to symbols task, they were ready to be administered the next task of blending sounds together. However, prior to blending the subjects received another brief demonstration. This demonstration was incorporated into the current study as a result of findings reported by Jeffrey and Samuels (1967). Their results indicated that in addition to matching sounds to symbols, children need to understand left to right sequencing and practice phonic blending to be successful at decoding words. Therefore, prior to blending sounds together, the experimenter provided the following demonstration to all subjects:

Look at these shapes. Let's pretend they are

letters. Here is the first letter and this is the second letter. Count how many letters there are while I point to them. (The examiner points from left to right while the child counts the letters).

The subjects were shown three two-letter words and instructed to point to and count the letters that appeared in each word as they moved their finger from left to right. Next, the children were given phonic blend training with the following instructions:

Now let's try something different. Say 'so'. Good. Now say 's-o'. (The examiner says the sounds slowly). Again, 's-o'. Make the first sound. Good. Now make the second sound. So, 's-o' makes the word 'so'. Once we know what sound a letter makes, we can put the sounds together to make a word. Watch me. This letter says _____. You say _____. And this letter says _____. You say _____. Good. Now listen as I put those sounds together. (The experimenter points to each letter, moving from left to right as she says the sounds slowly. Then she says it fast). Let's try it together. Follow my finger as I point to the letters. First we'll say it slowly; then we'll say it fast. Ready? Good. Now you try it. I'll point

to the letters while you say it. Good. Now you try it by yourself. Good.

If the subject did not respond correctly, the process was repeated. Otherwise the above process was followed for the two remaining sample words, 'me' and 'mow'. The subjects were then presented with four cards showing pairs of letter-like symbols to blend together into words. The following instructions were given for the first blending task:

Now I'm going to show you some new words. Can you put the sounds together and tell me what word this is?

The cards were presented one at a time. Praise was given for all attempts. Correct responses were recorded to indicate the subjects' successful performance in decoding any of the following four words: 'may', 'say', 'aim', and 'ace'. If the subjects were unsuccessful in correctly decoding any of the four words, the examiner immediately administered the second blending task and again recorded their performance. That is, following each unsuccessful attempt the examiner would tell the subject the correct sounds that represent the individual symbols

in a word and ask the subject to try again to identify the word. Therefore, the second blending measure eliminated the effects caused by recall and focused only on the subjects' ability to blend the sounds together. The following instructions were given for the blending task with assistance:

Now, what if I told you that this letter says ____ and this one says _____. Could you put these sounds together and tell me what word these sounds make _____?

Identifying three alphabetic letter names and sounds

Finally, two additional measures were administered to all the subjects in the current study. These measures were administered to determine if children's knowledge of the names and sounds for 'm', 's', and 'a' hindered their performance in learning tasks that required alphabetic sounds to be represented by artificial symbols. The subjects were shown three 8 x 5 cards displaying pairs of the same alphabetic letters ('Mm', 'Ss', and 'Aa'). The subjects were shown the cards one at a time for approximately 5 seconds each. In the first measure the examiner asked the child to identify the names of the

letters. Immediately following this task the examiner presented the cards again and asked the subject to identify the sounds for the letters.

Control group activities

Only the subjects in the experimental group received the distinctive feature training. However, all subjects in the current study received the same demonstrations in matching symbols with sounds, left to right sequencing and blending sounds together. The control group received only a brief warm-up activity prior to beginning the matching sounds to symbols and blending sounds together tasks. The warm-up activity consisted of presenting the subjects three simple matching tasks (Exercise A, B, and C) taken from the Peabody Individual Achievement Test (Dunn & Markwardt, 1983). This irrelevant warm-up activity of matching similar pictures (e.g., ball with a ball) was implemented to help establish a positive rapport between the examiner and the subjects.

Data Analyses

The SPSSX, Statistical Package for the Social Sciences, was used to analyze the data. Frequencies for each variable were calculated. In addition, the t-test was calculated to assess differences between the experimental and control group on language ability, intelligence and age in months. The SPSSX Pearson Corr program was also used to calculate the Pearson product-moment correlations among all the variables. Finally, for each dependent measure a 2 x 2 analysis of variance was calculated to investigate the main effects of and the interaction between the two independent variables of the study (visual discrimination training and language).

The language ability of the subjects in this study were assessed using the Test of Early Language Development (Hresko, Reid & Hammill, 1981). Children who scored above the median of 103 were defined as having high language ability, while those who scored below the median were defined as having low language ability.

Additional Analyses

It was considered of interest to examine the data from the experimental group's distinctive feature training sessions. Thus, frequency distributions of scores on the simultaneous and successive presentations were compared as well as performance on the repeated session.

An examination of the frequency distributions for the two training groups indicated a positively skewed distribution for the control group on matching sounds to symbols (see Results section). This skewness appeared to be the result of unusually high scores reported for two subjects. Therefore, a subsequent analysis was conducted after removing the two high scores reported on the matching sounds to symbols task. The additional analysis involved recalculating the mean and standard deviation of the control group on matching sounds to symbols and conducting an analysis of variance to provide more information about the effect of training upon the two groups.

Further analyses were also administered after the calculations from the analysis of variance indicated that there were differences between the high and low language

groups on matching sounds to symbols. Other research conducted among preschoolers (Huba & Robinson, 1986) had reported that scores on the Test of Early Language Development and the Slosson Intelligence Test were moderately correlated ($r=.47$). It was therefore believed that conducting a subsequent covariance that partialled out IQ might provide a better interpretation of the effects of language on this posttest. Therefore an analysis of covariance was conducted with the covariate IQ.

RESULTS

This section presents the results of the primary analysis for the six hypotheses examined in the study. Findings from additional analyses are also presented at the end of this section.

Hypothesis 1

One of the purposes of the current study was to investigate the effect of distinctive feature training on a subsequent reading task of matching sounds to symbols. The first hypothesis predicted that children who received the training would learn with a fewer number of trials to successfully match sounds to symbols than children without the training. Two measures were used to evaluate this question. One measure reported whether or not a subject could correctly match the three pairs of sounds and symbols on the first trial. The second measure reported the number of presentations required by a subject to correctly match the three consecutive pairs of sounds and symbols.

The trained (n=23) and untrained (n=23) groups were compared on the measures outlined above. It was

hypothesized that children who received the training would be superior in their performance on these measures than children without the training. However, when the first measure was administered, only three of the 46 (6%) subjects were successful in matching the sounds and symbols on the first trial. Two of these subjects were from the experimental group and one from the control group. The limited number of successful efforts on this task made any subsequent analysis meaningless. Therefore, only data collected for the second measure were used in analyses of the first hypothesis.

In the second measure the groups were compared on the number of presentations required by subjects before criterion was met. No significant difference was found between the experimental and control groups, $F(1, 42) = 3.41$. Table 2 shows the results of the analysis of variance on this measure and the main effect of training is shown beside the heading "training groups". Table 3 shows the means and standard deviations for the two groups on matching the sounds to symbols posttest. The mean score for the group receiving the training was 11.87 and the mean score for the group without the training was 21.13.

Table 2. Analysis of variance for number of presentations required by subjects to correctly match the three consecutive pairs of sounds and symbols

Source of	df	Mean square	F	p
Training groups	1	1084.38	3.41	.07
Language groups	1	1278.29	4.02	.05
2-Way interaction Training Language	1	530.05	1.67	.20
Explained	3	931.54	2.93	.04
Residual	42	317.69		
Total	45	358.61		

Note. $\alpha = .05$

Table 3. Means and (standard deviations) for number of presentations required by subjects to match sounds and symbols for training/language groups

Language Levels	Training Groups		
	Experimental	Control	Combined
High	13.67 (10.21) n=12	30.18 17.22 ^a (30.33) (9.11) ^b n=11	21.57 15.19 ^a (23.27) (9.68) ^b n=23
Low	9.91 (11.14) n=11	12.83 (12.64) n=12	11.43 (11.77) n=23
	11.87 (10.59) n=23	21.13 14.71 ^a (24.01) ^b (11.23) n=23	

^a Mean after two outliers were removed. ^b Standard deviation after two outliers were removed.

An analysis of the distribution of the scores within the control group revealed a positively skewed curve. The positively skewed curve represents a frequency distribution in which the frequency of small values is much greater than the frequency of large values. Two subjects contributing to this distribution reported scores of 99 and 78 on the number of presentations required to reach criterion, whereas all other scores were within the range of 1 to 39. It was of particular interest to note that the two subjects demonstrating this difficulty reported above average language scores of 115 and 110 and well above average IQ scores of 158 and 132, respectively. In addition, both subjects were considered young for this sample, with 51 and 56 months of age, respectively.

In a post hoc analysis to provide additional information about the relationship of training on mapping sounds to symbols, the two high scores were removed and the mean and standard deviation recalculated for the control group. A mean of 14.71 and a standard deviation of 11.23 were found. The analysis of variance was repeated. Again, no significant difference was found between the groups, $F(1, 40) = .94$. Therefore, even when the two high scores were eliminated from the data, the analysis indicated that the groups were considered equal

in their ability to learn to match sounds to symbols. Thus, hypothesis one was not confirmed. It is of interest to note, however, that the distribution among the subjects indicated that the task was extremely difficult for some preschoolers (e.g., 99 and 78 presentations) and very easy for others (e.g., 1 presentation).

Hypothesis 2

The current study was also designed to investigate the relationship between preschoolers' language ability and their performance on matching sounds to symbols. The second hypothesis predicted that children who demonstrated superior language ability would learn to match sounds to symbols in a fewer number of trials than those children who demonstrated low language ability. In relation to this second hypothesis, scores from the Test of Early Language Ability (Hresko, Reid & Hammill, 1981) were used to define the high and low language groups. To compare the performance of these two groups on matching sounds to symbols, two measures were used. The first measure was an indication of whether or not a subject could correctly match the three pairs of sounds and symbols on the first trial. The second measure reported the number of presentations required by a subject to correctly match the

three consecutive pairs of sounds and symbols.

The high language group (n=23) was compared with the low language group (n=23) on the measures outlined above. It was hypothesized that the children who demonstrated high language ability would be superior in their performance on these measures than children with low language ability. However, as already reported, only three subjects were able to successfully match the sounds and symbols on the first trial. Two of the subjects were from the low language group and one subject from the high language group. Therefore, subsequent analyses were eliminated on this measure.

Using the second measure, the language groups were compared on the number of presentations required to reach criterion. Table 2 shows the results of the analysis of variance on this measure and the main effect of language ability is shown next to the heading "language groups". A significant difference was found between the two language groups, $F(1, 42) = 4.02, p=.05$. Table 3 shows the means and standard deviations for the language groups on matching sounds to symbols. The mean score for the high language group was 21.57 and the mean score for the low language group was 11.43. That is, children with high

language ability demonstrated greater difficulty than children with low language ability in learning to match sounds with symbols.

The distribution of scores within the two groups was further analyzed. A positively skewed distribution was found among the high language group. Two scores contributed to the positively skewed distribution found in the high language group. Therefore, the two scores (78 and 99) were removed and the means and standard deviations recalculated. The new calculations reported a mean of 15.19 and a standard deviation of 9.68. The analysis of variance was repeated. The results of this analysis found no significant difference between the two groups, $F(1, 40) = 1.49$. That is, once the two high scores (78, 99) were removed from the high language group, the groups were considered equal in their ability to learn to match sounds and symbols.

Other research (Huba & Robinson, 1986) has reported that scores on the Test of Early Language Development (Hresko, Reid, & Hammill, 1981) are moderately correlated ($r=.47$) with scores on the Slosson Intelligence Test (Slosson, 1963). This same phenomenon was reported in the test manual with a substantial correlation coefficient of

.78 (Hresko, Reid, & Hammill, 1981). In the current study the correlation coefficient was .44 between the two variables. For this reason, and since each variable was somewhat correlated with the dependent measure (language with matching sounds to symbols: .24, $p=.056$; intelligence with matching sounds to symbols: $r=.29$, $p=.05$), an analysis of covariance was conducted with all 46 subjects using the covariate, IQ. By providing this further analysis, it was believed that a better understanding of the effects of language ability could be acquired. The results of this analysis indicated that once the effects of IQ were partialled out, the high and low language groups were considered equal in their performance on matching pairs of sounds and symbols.

In summary, hypothesis two was confirmed but in the opposite direction than was expected. However, results of the covariance showed that once the effects of IQ were eliminated the relationship between language ability and matching sounds to symbols no longer existed.

Hypothesis 3

The current study also was intended to investigate whether an interaction existed between preschoolers'

language ability and the visual discrimination training on the dependent variable matching sounds to symbols. For the third hypothesis, it was predicted that this interaction would show that children with advanced language ability would be more responsive to training about letter-like symbols than children with low language ability on mapping sounds to symbols. However, no interaction was found between language ability and visual discrimination training on the dependent measure. The analysis compared the number of presentations required by a subject prior to correctly matching the three consecutive pairs of sounds and symbols. Table 2 shows the results of the analysis of variance on this measure and the interaction effect of training and language ability is shown next to the heading "2-way interaction". No significant interaction was reported, $F(1, 42) = 1.67$. Thus, hypothesis three was not confirmed.

Hypothesis 4

The current study was also intended to investigate the effect of distinctive feature training on blending sounds together. For the fourth hypothesis, two measures were administered to assess the subjects' ability to blend sounds together. The first measure reported how

successful the subjects were in decoding four words presented individually to them. The scores on this measure ranged from 0, which indicated no words were correctly decoded, to 4, which indicated all words were correctly decoded. The second measure reported how successful the subjects were in blending words after the correct sounds had been pronounced for them. That is, if a subject was unsuccessful in correctly decoding any of the four words during the first measure, a second measure was administered in which the sounds representing the symbols were pronounced for the words not yet identified. The scores on the second measure also varied from 0 to 4. If a subject was successful in decoding one of the words during the first measure, the word was automatically counted correct on the second measure. Therefore, the scores on the second test were always equal to or greater than the scores on the first test.

In this fourth hypothesis it was predicted that the visual discrimination training would indicate no relationship with how well the subjects blend sounds together. As expected, no significant difference was found between the subjects receiving the training and those without the training, $F(1, 42) = .83$. Table 4 shows the results of the analysis of variance on this

Table 4. Analysis of variance for number of 'words' correctly blended without assistance

Source of	df	Mean square	F variation
Training groups	1	.36	.83
Language groups	1	.10	.24
2-Way interaction Training Language	1	.05	.11
Explained	3	.17	.38
Residual	42	.44	
Total	45	.42	

measure and the main effect of training is shown next to the heading "training groups". Table 5 shows the means and standard deviations for the two groups on this measure. The mean for the experimental group was .17 and the mean for the control group was .35.

Data from the second blending measure indicated that when subjects were assisted in their blending by having the sounds pronounced for them, their performance improved. Table 6 shows the results of the analysis of variance on this measure and the main effect of training is shown next to the heading "training groups". Again, no significant difference was found between the subjects receiving training and those without the training on this measure, $F(1, 42) = .19$. Table 7 shows the means and standard deviations for the two groups on this measure. The experimental group reported a mean of 1.00 and the control group a mean of .83.

A general trend of improvement was noted within both groups from the first to the second blending task. On the first measure subjects were asked to decode words without assistance. On the second measure subjects were given assistance when the examiner pronounced the isolated sounds for each symbol. The means from the first measure

Table 5. Means and (standard deviations) for number of 'words' correctly blended without assistance for training/language groups

Language Levels	Training Groups		
	Experimental	Control	Combined
High	.25	.36	.30
	(.62)	(.92)	(.76)
	n=12	n=11	n=23
Low	.09	.33	.22
	(.30)	(.65)	(.52)
	n=11	n=12	n=23
	.17	.35	
	(.49)	(.78)	
	n=23	n=23	

Table 6. Analysis of variance for number of 'words' correctly blended with assistance

Source of	df	Mean square	F variation
Training groups	1	.32	.19
Language groups	1	.32	.19
2-Way interaction Training Language	1	1.46	.85
Explained	3	.71	.42
Residual	42	1.70	
Total	45	1.64	

Table 7. Means and (standard deviations) for number of 'words' correctly blended with assistance for training/language groups

Language Levels	Training Groups		
	Experimental	Control	Combined
High	1.25	.73	1.00
	(1.42)	(1.91)	(1.31)
	n=12	n=11	n=23
Low	.73	.92	.83
	(1.27)	(1.31)	(1.27)
	n=11	n=12	n=23
	1.00	.83	
	(1.35)	(1.23)	
	n=23	n=23	

indicated that the task was slightly more difficult for the experimental group than for the control group (.17 and .35, respectively). However, only eight subjects from the total sample (N=46) could decode any of the two-letter words without assistance. This represented three from the experimental group and five from the control group. That is, eighty-three percent of the subjects were unable to correctly identify any of the words without assistance.

On the second measure when assistance was provided, performance improved for both groups. The experimental group showed the greatest gain between the two measures from .17 to 1.00. The control group also improved from .35 to .83. An analysis of variance was conducted to determine if there was a significant difference in the gain scores between the two groups. No significant difference was found between the experimental and control groups on this measure, $F(1, 42) = 2.05$. The direction of the means on the first task indicated that the experimental group may have found this task more difficult than the control group. However, once the effect of recalling the sounds was eliminated by the examiner's assistance, the experimental group exceeded the control group in successfully decoding words. As reported, however, in neither case was the difference significant.

The experimental group had three subjects who could correctly decode words on the first measure and twelve subjects on the second measure. The control group had five subjects who could correctly decode words on the first measure and nine on the second measure. In summary, hypothesis four was confirmed.

Hypothesis 5

This study also investigated the relationship between preschoolers' language ability and blending sounds together. Two language groups were compared. (Those scoring above the median on the language measure were considered the high language group; those scoring below the median were considered the low language group). For the fifth hypothesis, two measures were used to assess performance in blending. One measure reported the number of words successfully decoded without assistance. The second measure reported the number of words successfully decoded with assistance. The assistance involved pronouncing the sounds represented by the symbols. That is, if a child could not correctly decode a word, the examiner would pronounce the sounds and ask the child to put them together and try again to say the word. If a child was successful in decoding one of the words during

the first measure, the word was automatically counted correct on the second measure. Therefore, the scores on the second measure were always equal to or larger than the scores on the first measure. The scores on both measures varied from 0 (indicating no words correctly decoded) to 4 (indicating all words correctly decoded).

For this fifth hypothesis, it was predicted that the children who demonstrated a high language ability would perform in a superior manner to those children with less language ability. However, Table 4 shows that no significant difference was found between the two groups on the first measure of blending the sounds together without assistance, $F(1, 42) = .24$. Table 5 shows the means and standard deviation of the language groups on this measure. The mean for the high language group was .30 and the mean for the low language group was .22.

For the second measure of blending the sounds with assistance, Table 6 shows the results of the statistical analysis comparing the language groups. Again, no significant difference was found, $F(1, 42) = .19$. Table 7 shows the means and standard deviations of the language groups on this measure. The mean for the high language group was 1.00 and the mean for the low language group was

.83. Thus, hypothesis five was not confirmed.

Hypothesis 6

Finally, the current study investigated whether an interaction existed between preschoolers' language ability and the visual discrimination training on blending sounds together. For the final hypothesis it was predicted that there would be no interaction effect because both groups had already learned to visually discriminate the letters. As expected, Table 4 shows there was no significant interaction reported on the first measure, $F(1, 42) = .11$. This measure compared the number of words correctly decoded by the subjects without receiving any assistance from the examiner. The second measure compared the number of words correctly decoded following assistance from the examiner. Table 6 shows that no significant interaction was reported, $F(1, 42) = .85$. Thus, hypothesis six was confirmed.

Additional Analyses

Further analyses were conducted to provide additional information about distinctive feature training and preschoolers' language ability. Specifically, these

analyses pertained to the preschoolers' knowledge of three letter names and sounds, performance of the experimental group on the distinctive feature training, and an examination of other data describing two outliers.

Knowledge of letter names and sounds

An analysis was also conducted to determine if knowing the names and sounds of the alphabetic letters 'm', 's', and 'a' inhibited the subjects' performance by creating confusion on the dependent measures. In order to investigate this question, subjects knowledge of the names and sounds of the three letters were each scored from 0 to 3. A score of 0 indicated no knowledge of letter names or sounds. A score of 3 indicated correct identification of each of the three letter names or sounds.

When analyses of variance were conducted no significant differences were found between the two training groups on knowledge of letter names, ($F(1, 42) = .08$) and letter sounds, ($F(1, 42) = 1.37$). Similarly, no significant differences were found between the two language groups on knowledge of letter names, ($F(1, 42) = 3.38$) and letter sounds, ($F(1, 42) = 1.37$). In addition, none of the interactions were found to be significant on

knowledge of letter names and letter sounds. Table 8 shows the means and standard deviations on knowledge of letter names for the groups formed by the language and training variables. Means on knowledge of names for the experimental and control groups were 2.57 and 2.65, respectively, and 2.39 and 2.83 for the high and low language groups. Table 9 shows the means and standard deviations on knowledge of letter sounds for the four different groups. Means on knowledge of letter sounds for the experimental and control groups were 1.91 and 1.61, respectively, and 1.61 and 1.91 for the high and low language groups. Therefore, the results of these analyses indicated that the groups were considered equal in their knowledge of names and sounds for the letters 'm', 's', and 'a'.

Distinctive feature training

Data were also analyzed on the distinctive feature training received by the experimental group. Table 10 shows the means and standard deviations for the number of trials required to criterion in the simultaneous and successive presentations and also for the successive presentation that was readministered during the second session. The average number of simultaneous trials

Table 8. Means and (standard deviations) for number of letter names correctly identified for training/language groups

Language Levels	Training Groups		
	Experimental	Control	Combined
High	2.42 (1.00) n=12	2.36 (1.03) n=11	2.39 (.99) n=23
Low	2.73 (.65) n=11	2.92 (.29) n=12	2.83 (.49) n=23
	2.57 (.84) n=23	2.65 (.78) n=23	

Table 9. Means and (standard deviations) for number of letter sounds correctly identified for training/language groups

Language Levels	Training Groups		
	Experimental	Control	Combined
High	1.67 (.78) n=12	1.55 (1.04) n=11	1.61 (.89) n=23
Low	2.18 (.87) n=11	1.67 (.98) n=12	1.91 (.95) n=23
	1.91 (.85) n=23	1.61 (.99) n=23	

Table 10. Means and (standard deviations) for number of trials to criterion in the distinctive feature training for experimental group

Simultaneous mode	Successive mode	Repeated session
1.48 (.67)	2.44 (1.44)	1.13 (.46)

required by the experimental group was 1.48; whereas, the average number of successive trials was 2.44. As expected, the subjects demonstrated greater difficulty with the successive presentations. Nonetheless, when the successive presentation was readministered in the second session, the mean was 1.13. Therefore, once the visual discrimination of letter-like symbols was learned, the information appeared to be retained.

The t-test was calculated to assess whether the differences in the number of trials between the presentations were statistically significant. When the simultaneous and successive presentations were compared, a significant difference was found, $t(22) = -3.28$, $p = .01$. In addition, when the successive presentation administered during the first session was compared with the same mode readministered in the second session, a significant difference was also found, $t(22) = 4.04$, $p = .01$.

Table 11 shows the frequencies for the number of trials required by individual subjects to meet criterion. When a simultaneous mode was used, the majority (61%) of subjects needed only one trial to reach criterion. However, when a successive mode was used, only 30% were successful after one trial. The greater difficulty

Table 11. Frequency distribution of number of trials to criterion in distinctive feature training for experimental group

Number of trials required	Simultaneous mode	Successive mode	Repeated session
1	14 (61%)	7 (30%)	21 (91%)
2	7 (91%)	6 (57%)	1 (96%)
3	2 (100%)	6 (83%)	1 (100%)
4			
5			
6			
7		1 (100%)	

Note. Percentages are cumulative.

already reported for the successive presentation was again noted in these varying percentages. However, in the second session of the distinctive feature training when subjects were requested to match the symbols again in the successive mode, 91% were successful on the first trial.

Finally, an analysis of the percentage of errors accumulated on these trials was examined. The mean percentages of errors reported for the experimental group on the simultaneous and successive presentations, respectively, were 2.67 and 7.93. The mean percentage of errors for the successive presentation readministered in the second session was .78. These percentages are reflective of the trend already reported for the experimental group on distinctive feature training.

The performance of the two language groups on the distinctive feature training was also believed to be of interest. Table 12 shows the means and standard deviations for the high (n=12) and low (n=11) language groups on the simultaneous and successive presentations and also for the successive presentation readministered during the second session. The means represent the average number of trials required to reach criterion. The means for the high language group on these three

Table 12. Means and (standard deviations) for number of trials to criterion in the distinctive feature training for language groups

Mode	High language (n=12)	Low language (n=11)
simultaneous	1.58 (.79)	1.36 (.51)
successive	2.50 (1.68)	2.36 (1.21)
successive (session 2)	1.08 (.29)	1.18 (.60)

presentations were 1.58, 2.50, and 1.08; while the means for the low language group were 1.36, 2.36, and 1.18, respectively.

The t-test was calculated to assess the differences between the two language groups on the number of trials required for each presentation. When the two groups were compared on the number of simultaneous presentations required to reach criterion, no significant difference was found, $t(21) = -.78$. Similarly, when the high and low language groups were compared on the number of successive presentations, again no significant difference was found, $t(21) = -.22$. In addition, when the two groups were compared on the number of successive presentations required during the second session, no significant difference was found, $t(21) = .49$. Thus, it appears that the two language groups can be considered equal in their ability to visually discriminate among the letter-like symbols.

Examination of two subjects

Finally, further examination seemed warranted for the two subjects that reported considerable difficulty in matching sounds to symbols (e.g., 99 and 78

presentations). The two particular subjects were well above average in IQ (158 and 132, respectively) and language ability (115 and 110, respectively). They could also correctly identify most letter names used in this study (3 and 2, respectively) and one letter sound. In addition, they were considered young subjects for this study (51 and 56 months of age) and were unable to successfully decode any of the words presented in the two blending posttests.

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate whether training preschoolers to note the contrastive features among highly similar artificial letters would facilitate learning to map a sound to a symbol or blend sounds together. In addition, this study also investigated whether children with high language ability would perform in a superior manner on these tasks than children with low language ability.

Distinctive Feature Training and Task Performance

This study hypothesized that preschoolers receiving the distinctive feature training would be superior in matching sounds to symbols than those preschoolers without the training. However, no significant difference was found between the two groups in matching sounds to symbols. This finding was not expected because research had indicated that distinctive feature training improves preschoolers' ability to distinguish among letters (Nelson & Wein, 1974, 1976; Tawney, 1972; Williams, 1969) and facilitates learning letter names (Samuels, 1973). The current study's results appear to lack support for these

conclusions.

It might therefore be argued that the current study using preschoolers and artificial symbols differed substantially from the distinctive feature training investigated by Samuels (1973). In the latter study, the author used alphabetic letters rather than the artificial symbols used in the current study. The task of matching alphabetic letters to alphabetic names may not have been analogous to a task of matching artificial symbols to alphabetic sounds. In addition, Samuels selected kindergarten subjects to participate in his study who were unable to name or recognize the alphabetic letters 'b, d, p, and q'. In the present study, no attempt was made to select only children who demonstrated difficulty in identifying the three alphabetic sounds used in the dependent measures. Therefore, it may be suggested that Samuels investigated a selective population that differed substantially from the one used in the present study. In summary, the combination of a selective population and a task using alphabetic letters may not have provided appropriate evidence for predicting that distinctive feature training would facilitate learning to match sounds and symbols.

However, analyses of the present study's data on matching sounds to symbols did reveal a trend that favored the performance of the experimental group. Indeed, subjects who had received the distinctive feature training required a fewer number of presentations to learn to match a sound to a symbol. This noted trend may be the result of random error or perhaps the result of true differences that exist between the groups. If these differences actually exist, it may be that the sample size selected for this study was inadequate for finding statistical significance. Ninety subjects participated in Samuels' (1973) government funded study on letter names, while only 46 participated in the current study. However, the number of participants used in the present study was believed to be appropriate based on sample sizes reported by other researchers investigating distinctive feature training (Nelson & Wein, 1974, 1976; Tawney, 1972; Williams, 1969).

Nevertheless, it should be noted that the overall results found by other researchers in terms of the effectiveness of distinctive feature training were also found in the current study. That is, preschoolers could match symbols more easily in a simultaneous mode than in a successive mode as had been reported earlier by Samuels (1969, 1973). Secondly, the current study's findings

indicated that once children learned to distinguish among symbols they appeared to retain this information even when a number of days transpired between training sessions. This finding was consistent with researchers (e.g., Williams, 1969) who have reported significant improvement in letter discrimination as a result of receiving distinctive feature training. Finally, results from the present study were supportive of researchers (e.g., Tawney, 1972) who have noted that considerable variability exists among young children in learning to distinguish among symbols. In conclusion, distinctive feature training is effective for learning to visually discriminate among letters; and the current study found the same pattern of subject responses reported by other researchers investigating this phenomenon.

With regard to the effect of distinctive feature training on blending sounds together, the experimental group was not expected to differ from the control group on the dependent measures. The results confirmed this, with the groups considered equal in their performance on blending sounds together. Due to the nature of the sequencing of tasks in this study, it was hypothesized that the visual discrimination training would no longer be relevant for two reasons: 1) all the preschoolers would

have already learned to distinguish the symbols as part of the process of learning to match a sound to a symbol, and 2) the task was believed to be primarily dependent upon linguistic abilities.

Language Ability and Task Performance

The present study also investigated the relationship between preschoolers' language ability and their facility in matching sounds to symbols. It was predicted that children with high language ability would learn to match sounds to symbols in a fewer number of presentations than children with low language ability. Although a significant difference was found between the two language groups, the means indicated that it was the low language group that learned to map sounds to symbols in the fewest number of presentations. Additional analysis found that two subjects in the high language group had extremely high scores on the matching task (e.g., 78 and 99). Therefore, the mean and standard deviation reported for the high language group was unusually high. When the two subjects were removed, the recalculated mean still indicated greater difficulty for the high language group but the difference was no longer statistically significant.

The difficulty experienced by the high language group on matching sounds to symbols may indirectly support research suggesting that some children use strategies to store and retrieve information that can actually cause interference in learning particular reading-related tasks (Mann, Liberman & Shankweiler, 1980; Shankweiler, Liberman, Mark, Fowler, & Fischer, 1979). Using Vellutino's (1979) supposition that language ability distinguishes normal readers from poor readers, several research studies appear relevant to the current study's findings.

A number of studies report (Byrne & Shea, 1979; Mark, Shankweiler, Liberman, & Fowler, 1977; Shankweiler & Liberman, 1976) that good and poor readers differ significantly in the type of strategies they use to remember letters and words. Good readers more than poor readers show evidence of greater reliance on phonetic representation as a way of remembering words presented in written or spoken form. Phonetic representation refers to the ability to use the aural characteristics of written and verbal letters to store and retrieve information in short-term memory. Indeed, Shankweiler, Liberman, Mark, Fowler, and Fischer (1979) reported that normal readers have so strong a tendency to store information in phonetic

form that they persist in using this form of coding even when it penalizes recall. Poor readers, on the other hand, have indicated considerable difficulty in using this particular strategy. Therefore, they are more inclined to use nonphonetic strategies (i.e., visual or semantic) as a means of remembering letters or words (Fowler, Liberman, & Shankweiler, 1977; Shankweiler & Liberman, 1972).

The high language group in the current study, like the good readers cited in the studies above, may have attempted to match sounds to symbols by storing the target shapes in some phonetic form. The low language group, on the other hand, may have been more likely to use a visual strategy that for this task proved more effective in learning to match sounds to symbols. An example of how the visual coding may have helped would be to consider the symbol that represented the designated 'a' sound. The low language group, using a visual strategy, could have associated the artificial symbol 'A' with the structurally similar lower-case alphabetic 'a' symbol. Based on the research cited here, it could be suggested that the low language group more than the high language group used visual coding to facilitate learning this task.

Although phonetic coding of information is a

generally effective and a necessary strategy in learning to read, it may have caused interference on matching artificial symbols with alphabetic sounds. This speculation would be in harmony with researchers who have suggested that phonetic coding may cause interference in learning some tasks in which a linguistic component is involved. Shankweiler, Liberman, Mark, Fowler, and Fischer (1979) conducted a study in which second graders were asked to recall the names of five alphabetic letters that either did or did not rhyme. Good readers were greatly handicapped by rhyme, whereas the poor readers performed at about the same level for both rhyming and nonrhyming sets. The authors concluded that children who are predisposed to use phonetic coding may be penalized when a linguistic component exists that does not facilitate learning the task (i.e., letters that rhyme). The results of the current study would appear to indirectly support the suggestions of these authors. When the children were asked to visually discriminate the artificial symbols, the high language group performed as well as the low language group. However, once a language component was added in the subsequent task of matching sounds to symbols, the high language group's performance appeared to be impaired.

Since artificial symbols were used in the present study, it might be argued that the reported preference for phonetic and nonphonetic strategies is not applicable. However, research suggests that normal readers will try to store information phonetically regardless of whether the stimuli is alphabetic or logographic (Erickson, Mattingly, & Turvey, 1977; Tzeng, Hung, & Wang, 1977). Indeed, there is some evidence that suggests that even when the stimuli are not linguistic items, but are rather pictured objects, normal readers attempt to store the information phonetically in memory (Shankweiler, Liberman, Mark, Fowler, and Fischer, 1979).

Another factor that may have contributed to the poor performance of the high language group is their rich linguistic background. Although the high and low language groups were equal in their knowledge of the three letter names and sounds used in this study ('m', 's', and 'a'), other linguistic information (i.e., graphic, semantic, and phonemic) that was not assessed may have created confusion. One might therefore speculate that the alphabetic letter sounds could have activated many of the associations held by children with higher levels of linguistic awareness, causing further confusion. This is one explanation offered by Huba, Vellutino, and Scanlon

(1987) in a study where normal readers were less accurate than poor readers when they were attempting to recall an auditory target letter while shadowing (verbally repeating) a series of letter names aloud.

The current results provide only indirect support for the suggestions mentioned above, but they do provide plausible explanations for the poor performance of the high language group. Although the evidence is inconclusive, the combination of a preference for phonetic coding and a rich network of linguistic associations may have created interference for the high language group.

One might therefore argue that the difference found between the groups on the matching task was due to general intelligence rather than language ability. However, it should be mentioned that even from this perspective it would have been the more skilled subjects (with high IQ) rather than the less skilled subjects (with low IQ) that took longer to learn to match sounds and symbols. To examine this, the effect of IQ was removed in a subsequent analysis to provide a better understanding of the impact of language ability on matching sounds to symbols. Once the variance due to IQ was partialled out, there was no difference between the groups in how quickly they learned

to match sounds to symbols.

This finding might be explained by a boredom hypothesis suggesting that preschoolers of high intelligence become more quickly bored with arduous tasks (e.g., matching artificial symbols to sounds). However, this argument seems unlikely. Although the task was not particularly interesting to the subjects, the experimenter took certain precautions to reduce the hazards caused by boredom. First, a rapid pace was maintained in the presentation of individual cards (5 seconds each). Secondly, to encourage interest in the task it was introduced as a game in which the subject was told to try and beat the experimenter. Finally, at the beginning of all sessions, subjects were told they could stop at anytime during the 'game'. (None did). Thus, considering the superior performance of the low IQ group and the precautions cited above, the general ability notion seems an unlikely explanation for results found in the current study.

It should also be noted that the measure used to assess intelligence in this study was the Slosson Intelligence Test (Slosson, 1963). This particular measure consists primarily of verbal items and may in part

actually describe differences in language abilities. (A correlation coefficient of .44 was noted between the language and intelligence measures in this study). A case might be made that when the variance on a verbal IQ measure such as the Slosson is partialled out in a covariance analysis, the effect of the very characteristics that distinguish the high from the low language group may be diminished. Vellutino (1979) has provided some support for this contention. He has reported that the differences in language ability between reader groups are manifested in the consistent differences found between poor and normal readers on verbal IQ measures. Typically, poor readers are characterized by an IQ pattern that depicts lower verbal than performance scores, reflective of their language deficiencies.

The current study also examined the effects of preschoolers' language ability on blending sounds together. It was hypothesized that because the blending tasks were largely dependent upon language ability, the high language group would perform better than the low language group on these measures. However, no significant difference was found between the two groups in their ability to blend the sounds together. This result may be attributable to the difficulty of the task. Researchers

(Jeffrey & Samuels, 1967; Ehri & Wilce, 1985) have suggested that learning to blend words requires considerable practice and instruction. In the present study less than half (21) of the subjects could successfully blend any of the four 'words', even after the sounds were identified for them. It would therefore appear that the limited instruction provided in the current study may not have been adequate for preschoolers.

Nonetheless, an interesting trend was noted between the two language groups. In learning to match a sound to a symbol, the high language group demonstrated significantly greater difficulty than the low language group. However, in blending the sounds together, the reverse was true (although not statistically significantly different), with the low language group demonstrating greater difficulty. It may therefore be concluded that the rich linguistic background of the high language group created interference for the superior group on the matching task. However, once the sound-symbol associations were learned the more sophisticated language group found blending the sounds together no more difficult, and even perhaps less difficult, than the low language group.

Evaluation of Two Subjects

The two subjects that demonstrated the greatest difficulty with the matching sounds to symbols task may be indicative of a subset that might profit from visual discrimination training. Although it appears that most preschoolers automatically learn to visually discriminate among symbols as they learn to match sounds to symbols, other subjects demonstrate considerable difficulty. It may be that some subset of preschoolers would benefit from receiving distinctive feature training in learning subsequent reading skills. As already reported, the two particular subjects were well above average in IQ and language ability. They could also correctly identify most letter names used in the study and one letter sound. It was also noted that they were considered young subjects for this study (51 and 56 months of age).

From one point of view, it may be argued that the difficulty experienced by these two subjects was indicative of their young age. This argument would be consistent with Mason's suggestion (1980) that the initial stage of reading is "context dependent". In this stage, prereaders reportedly do not focus on the individual letters. Hence, the two subjects' reported difficulties

may support Mason's developmental process that young children reportedly move through in their acquisition of reading. That is, the "context dependent" child is not ready to learn such reading related tasks as mapping sounds to symbols. Only when the child reaches the second stage of visual discrimination of letters are they likely to be receptive to learning such tasks. Therefore, if these developmental stages do exist, a question that remains unanswered is whether the "context dependent" child would benefit more from distinctive feature training or a time lapse in which no instructional intervention was offered.

Distinctive Feature Training

The intent of this study was to determine if distinctive feature training would facilitate learning subsequent reading tasks. However, considerable information was also learned about visual discrimination training itself. The performance of the 23 subjects who received this training indicated that in all cases the simultaneous presentation of symbols was easier for preschoolers than the successive presentation of symbols. Nevertheless, once the preschoolers learn to match symbols, the ability to visually discriminate among the

symbols is retained. This was demonstrated when 91% of the subjects in the second session successfully matched the symbols on the first trial. This finding supports other studies that have indicated that distinctive feature training is an effective means of teaching letter discrimination. However, it also appears that most children automatically learn to visually discriminate among letters as a natural part of learning to match sounds to symbols. Thus, for the majority of preschoolers, distinctive feature training may not be necessary.

Summary and Recommendation for Further Study

The current study set out to investigate whether distinctive feature training would assist preschoolers in learning subsequent reading tasks, such as mapping sounds to symbols and blending sounds together. The results of the present study failed to support the suggestion that distinctive feature training is an effective prereading activity (e.g., Guralnick, 1972). That is, no evidence was found to suggest that this visual discrimination training facilitates learning the two reading tasks of mapping sounds to symbols and blending sounds together. The data presented in this study simply indicated that distinctive feature training is an effective means of teaching preschoolers to distinguish among highly similar letters. The results indicated that once preschoolers learn to note the structural differences among letters they retain this information. However, as reported, statistical differences were not found between the two groups on matching sounds to symbols or on blending sounds together. It would therefore appear that preschoolers automatically figure out the contrastive features of symbols on their own as a natural part of learning to match sounds and symbols.

Nevertheless, research has consistently reported that some preschoolers have considerable difficulty in noting the differences among highly similar letters (e.g., Gibson et al., 1962). Therefore, training that emphasizes the contrastive features found among letters may be a worthwhile practice for some particular subset of preschoolers. The results of the present study would indicate that additional research is needed to determine what preschoolers comprise this subset and whether distinctive feature training would eliminate this difficulty.

The present study also investigated the relationship between children's language ability and their facility in learning to map sounds to symbols and blend sounds together. For apparently contradictory reasons, the results may give indirect support to other research that suggests that language may play a substantial role in learning to read (e.g., Vellutino, 1979). Although the high language group had no difficulty in learning to visually discriminate among letter-like symbols, they found the matching sounds to symbols task notably more difficult. Thus, it may be that their facility with language impaired the performance of the more sophisticated language group.

This apparent contradiction (i.e., that the poor performance of linguistically advanced children is indicative of the facilitating role of language skills in reading) is compatible with the point of view of some researchers (e.g., Shankweiler, Liberman, Mark, Fowler, and Fischer, 1979). They have suggested that some children use strategies to store and retrieve information (e.g., employing a strong coding preference) that penalize their performance on some tasks. Good readers reportedly rely on a phonetic coding system, whereas poor readers attempt to code information using a nonphonetic coding system. This persistence in using a preferred coding strategy was suggested to be a contributing factor to the poor performance of the high language group. Using Vellutino's (1979) explanation that poor and normal readers differ primarily in language abilities, the language groups were believed to be analogous to the reading groups. Nevertheless, further research is needed to determine if language groups can be distinguished by the type of coding strategy they employ. In addition, only school-aged populations have been studied. Siegel and Linder (1984) have suggested from their study with children of varying school-ages that this phenomenon may be developmental. Given the results of the present study

involving preschoolers, the developmental nature of a preferred coding notion warrants further study.

Another factor that was suggested to have contributed to the poor performance of the high language group on matching sounds to symbols was their rich linguistic awareness. This was one explanation provided by Huba, Vellutino, and Scanlon (1987) in a study that found normal readers to be less accurate than poor readers in a task of auditory target letter recall. However, empirical evidence is lacking to support this supposition. Therefore, additional research is needed to adequately assess whether or not complex linguistic associations might interfere with performance on a task.

For example, in a study of the ability of preschoolers to match alphabetic sounds to artificial letters, that assessment should include identification of all alphabetic letters and sounds, as well as identification of words that rhyme with or remind the subject of the target letters. If a rich linguistic facility contributes to interference on this particular task, then more information would be expected to be identified (e.g., letters, sounds, word associations) for subjects of high language ability who experience

difficulty in completing the task.

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